SOL Engineering Test: GRIP-T09
Using a Linear Actuator Encoder for Stall Detection

Tester: Tony Whyte	**Test Date:** July 5 – 16 2010	**Start Time:** N/A	**Test Type:** Engineering
Component/ Module under test: Haydon Kerk Linear Actuator(s), Stepper Motors	**Drawing:** N/A	**Rev:** N/A	**Lot:** N/A

Purpose:

- Determine if the Linear Actuator encoder feedback signal can be used as a means to detect a motor stall point.
- Also determine that once at the stall point the force applied is consistent and held over time.

References:
N / A

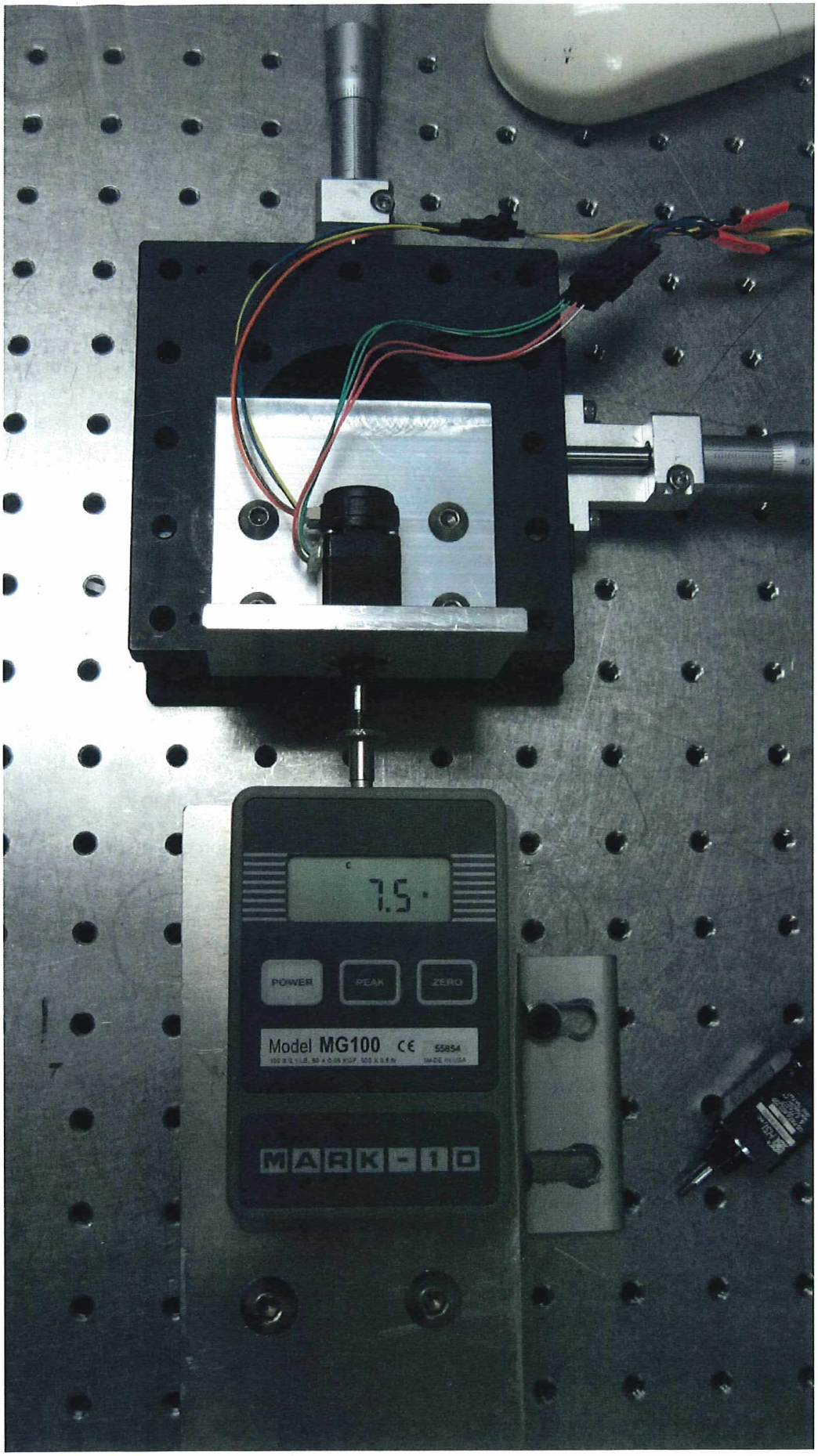
Expected Results (Pass/Fail Criteria):

1. The encoder step count does stop incrementing at hard stop extremes (stall point). The stall point is defined as the motor being commanded to move two consecutive steps without encoder advancement.
2. The force level increases linearly with an increase in current to the gripper motor.
3. The force level exhibits roughly sinusoidal behavior when motor is attempted to be driven beyond hard stop limit/stall point.
4. The force level at which encoder stops incrementing is consistent over time.

A Pass will be given if all of the above expected results are supported by data and observation.
A Fail will be given of one of the above expected results cannot be supported by data and observation.

Materials:

1. Haydon Kerk, Models 21H4K, 21HAB Gripper motor fixtures, with encoders.
2. OptoSigma Micrometer adjustable stage device
3. MARK-10, Model MG100, Digital Force Meter (.5 Newton resolution.)
4. QNX Neutrino 6.3 Workstation with control/status connectivity to a OCD laboratory "Black Box" with a DSP Board present


7.5
POWER
PEAK
ZERO
Model MG100
MARK-10

12. Adjust the micrometer such that a reasonably small number of interactive steps are required (<75 e.g)) to contact the force meter surface and register non-zero values.

13. Repeat data collection all current level settings (1-9) for this new motor model.

These steps address expected result item 4.

1. Run the "encoder" script and note the value of the force level on the meter as script iterates through current levels 3, 4, and 5.

2. Repeat running of "encoder" script and collection of force values for 10 to 20 additional iterations.

3. Make changes for the 0 level Hold Current aspect of expected result item 4. Here we are interested in capturing the force level that persists when the Hold Current Delay expires

   a. In 'setup' script ensure that the setting of the current scales variable reads as
      my @currentScales1 = ("3", "3", "0");

   c. Edit the 'encoder' script such that
      `dspdevmsg $dsp 300 0x021 $motor 10000 `; # SetMotorHoldCurrentDelay() = 10s

      command line reads as

      `dspdevmsg $dsp 300 0x021 $motor 1000 `; # SetMotorHoldCurrentDelay() = 1s

   b. Edit the 'encoder' such that it reads
      `dspdevmsg $dsp 300 0x034 $motor $current $current 0 `; #SetMotorHoldCurrent to 0

4. Run the "encoder" script and note the value of the force level on the meter as script iterates through Current levels 3, 4, and 5.

5. Repeat running of "encoder" script and collection of force values for 10 to 20 additional iterations.

Data :

GripperEncoder.xls

Calculations:
N/A

Observations:
None

Test Results: Relevant to Expected Result Items 1, 2, 3
The testing agreed with the predicted results. This includes

1. Figure 1 and Figure 2 show that at all current levels there is a predictable linear relationship between current applied and the resultant force. The expected sinusoidal behavior of the current, as the motor is stepped beyond the stall point, was observed.

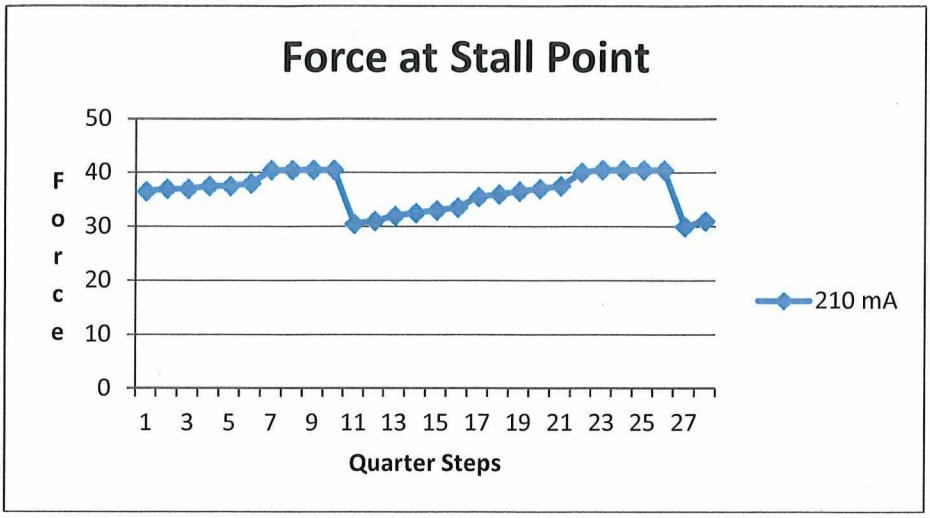


Figure 3

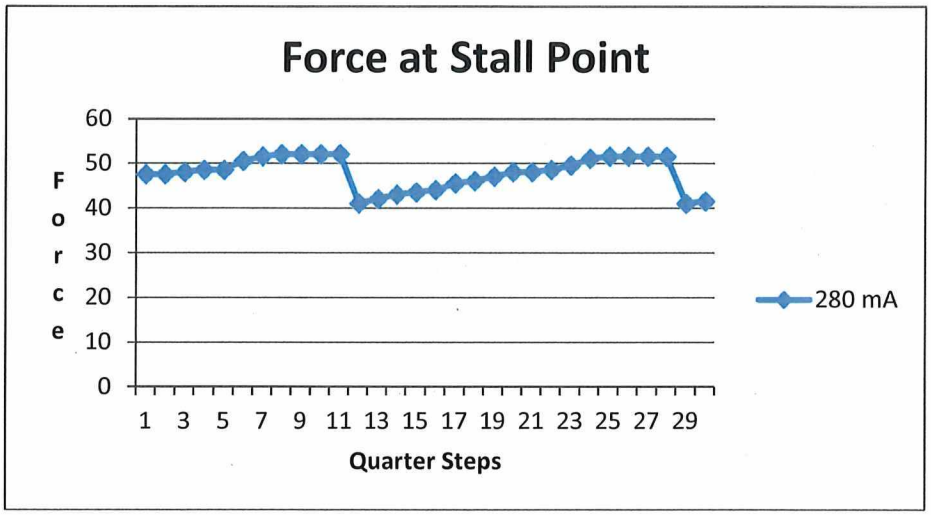


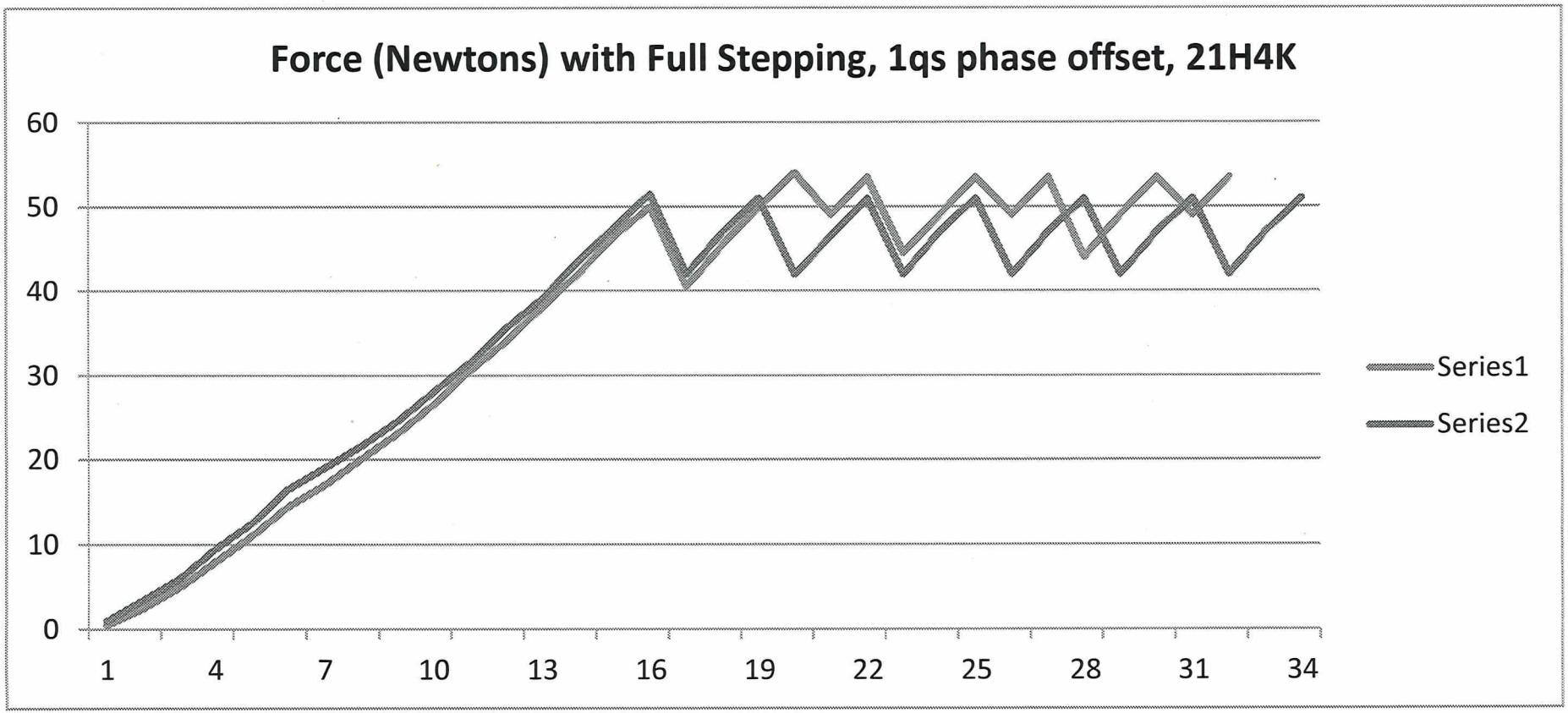
Figure 4

Test Results: Relevant to Expected Result Item 4

1. There was negligible change over time in the force value for a given current level, at the point of stall. The encoder script drove the motor to the point of stall and then stop. The following is a table of the force Values at three different current levels. Refer to tables 1 and 2.

(210 mA)	(280 mA)	(350 mA)
41.5	57	73
41.5	57.5	73
41.5	57	73
41.5	57	73
41.5	57	73
41.5	57	73
41.5	57	73
41.5	57	73
41.5	57	73
41.5	57	73

Table 1: Force at Hold Current = Run Current



Current level 5